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PC/UNIX/WORKSTATION CAD/ESTIMATING

OR

THE CHALLENGES IN DEVELOPMENT OF AUTOMATIC CAD
ESTIMATING FOR GOVERNMENT AND AEROSPACE
CONSTRUCTION AND GSE

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OR

CAD/ESTIMATING

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(NASA-TM-109322)
PC/UNIX/WORKSTATION CAD/ESTIMATING
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THE CHALLENGES IN DEVELOPMENT OF AUTOMATIC CAD
FOR GOVERNMENT AND AEROSPACE CONSTRUCTION COST
ESTIMATING SYSTEMS

OR

CHALLENGES DEVELOPING CAD/ACE

OR

CHALLENGES DEVELOPING MINI-COMPUTER
CAD/ESTIMATING
FOR GOVERNMENT AEROSPACE CONSTRUCTION

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INTRODUCTION - SUMMARIZING THE MANY YEARS OF EFFORT IN DEVELOPING COMPUTER AIDED DESIGN/AUTOMATIC COST ESTIMATING USING A VAX MINI-COMPUTER (CAD/ACE) WITH REASONS, PURPOSE, GOALS, POSSIBLE PRODUCTIVITY IMPROVEMENTS, AND DIFFICULTIES TO HELP THE CONSTRUCTION INDUSTRY UNDERSTAND WHY AND HOW TO USE THIS FUTURISTIC COST ESTIMATING SYSTEM. THE NEW GENERATION OF CAD/ ESTIMATING WILL BE BETTER, FASTER, CHEAPER, AND BENEFIT THE GOVERNMENT, AEROSPACE AND CONSTRUCTION BY (1) IMPROVING ESTIMATING ACCURACY, (2) SAVING TIME IN ESTIMATING BY MAKING IT FASTER AND MORE AUTOMATIC, (3) PROVIDING TIME FOR MORE COST ENGINEERING AND, ULTIMATELY, (4) MORE COST EFFECTIVE AND EFFICIENT CONSTRUCTION.

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MANUAL AND COMPUTER ESTIMATING METHODS REQUIRE TIME-CONSUMING QUANTITY TAKEOFFS, LOOKING UP, PRICING OUT AND MARKING UP OF COST ESTIMATES. A CAD/ESTIMATING SYSTEM CAN DO THIS FASTER AND BE MORE ACCURATE, USING THE CAD DRAWING FILE FOR QUANTITIES EXTRACTION WITH AN EFFICIENCY ANALYSIS OF MANUAL VERSUS COMPUTER ESTIMATING. THE CAD ESTIMATING SYSTEM BEING TESTED WILL BE SHOWN ALONG WITH A SAMPLE COMPUTER ESTIMATE, BIDS, CAD ESTIMATES AND MENU.

PRESENT AND FUTURE TYPES OF ESTIMATES

MANUAL ESTIMATING HAS BEEN USED BY GOVERNMENT AND GENERAL CONTRACTOR ESTIMATORS FOR OVER 75 YEARS AND WILL CONTINUE TO BE USED BY THEM FOR THOSE MANY APPLICATIONS WHERE COMPUTER ESTIMATING IS NOT COST EFFECTIVE; SUCH AS UNIQUE, ONE-OF-A-KIND, COMPLEX PROJECTS WITH TOO MANY VARIABLES TO JUSTIFY EXTRA TRAINING, CUSTOMIZED COMPUTERIZATION, ETC.

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PRESENT AND FUTURE TYPES OF ESTIMATES (CONTINUED)

A RECENT SURVEY OF 119 MANUAL VS. COMPUTER ESTIMATES SHOWS 71% MAKING MANUAL ESTIMATES AND ONLY 29% MAKING COMPUTER ESTIMATES. THIS IS AFTER 20 YEARS OF COMPUTER ESTIMATING. HOWEVER, 70% OF THOSE SURVEYED WANT TO MAKE AND USE COMPUTER ESTIMATING SUCCESSFULLY. THE TREND TOWARD MORE COMPUTER ESTIMATING SHOULD CONTINUE AS COMPUTER ESTIMATING BECOMES FASTER, CHEAPER, MORE ACCURATE AND EASIER TO USE; ESPECIALLY WITH DIGITIZED ESTIMATING, VOICE RECOGNITION, ARTIFICIAL INTELLIGENCE, AND CAD/ACE. COMPUTER ESTIMATING CAN BE JUSTIFIED ON REPETITIVE TYPE PROJECTS OR WHEN TWO OR MORE ESTIMATES ARE REQUIRED.

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GOVERNMENT - PRESENT & FUTURE TYPES OF ESTIMATES

1. MANUAL ESTIMATE, KSC SPEC G-0002, TR 5-800
2. COMPUTER ESTIMATES, CES/CACES/DOE
3. DIGITIZED ESTIMATING
4. CAD/ESTIMATING
 - A. MINI-COMPUTERS - CAD/ACE BEING DEVELOPED AND TESTED BY NASA/INTERGRAPH/IBISCALC
 - B. UNIX WORKSTATION CAD/ESTIMATING

GOVERNMENT - PRESENT & FUTURE TYPES OF ESTIMATES
(CONTINUED)

4. CAD/ESTIMATING (CONTINUED)
 - C. 3-D MODELING CAD ESTIMATING (EMS/CATIA)
 - D. PC-CAD ESTIMATING (AUTO CAD/TIMBERLINE)
 - E. MACINTOSH PC/CAD ESTIMATING

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FIVE METHODS OF CAD ESTIMATING

1. THE VAX/INTERGRAPH/IBISCALC NAVY DATABASE
2. PROFIT CAD -2D- RESIDENTIAL/CUSTOM HOME
BUILDER D/B
3. 3-D MODELING CUSTOMIZED CAD/ESTIMATING D/B
4. WORKSTATION CAD ESTIMATING USING
INTERGRAPH/G-2/RICHARDSON D/B
5. AUTO/CAD TIMBERLINE WITH CUSTOMIZED D/B

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BACKGROUND COMPUTER, CONSTRUCTION, COST ESTIMATING

- O VAB CONSTRUCTION USING COMPUTERS - STEEL/CPM,
1963-1967
- O 1969 COMPUTERS IN CONSTRUCTION SYMPOSIUM/
COMPUTER ESTIMATING PIONEERS CREATORS - ORR,
ENYEDY, PAPAVERO
- O 1972 KSC MANAGEMENT MEMO COMPUTER ESTIMATING
BENEFIT
- O 1974 KSC/DE/PRC APPLICON CAD CONTRACT
DRAFTING/B.O.M.

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TRIAL USE OF COMPUTER ESTIMATING, 1979/80

1. **FRUSTRATION WITH EQUIPMENT**
 2. **RESISTANCE TO NEW WAYS**
 3. **INABILITY TO COMPREHEND COMPLEX FLEXIBILITY**
 4. **POOR ESTIMATING/COST ENGINEERING MANPOWER CAPABILITY**
 5. **EXPECTED AUTOMATING COMPUTER COST ESTIMATING**
 6. **FEAR - STRESS, FATIGUE**
-

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COST ENGINEER OBSERVER COMMENTS, 1980/81

1. **COMPUTER ESTIMATING SYSTEM MUST BE MADE SIMPLER**
2. **REDUCE DATA ENTRY/LOOK-UP COST CODES**
3. **USE CAD FOR QUANTITIES**
4. **DEVELOP PROGRAM FOR STANDARD FORMAT**
5. **PROVIDE COMPUTER/CE TECHNICAL SUPPORT DURING LEARNING PHASE, 6 MO. TO 3 YRS.**
6. **NEEDS MORE EXTENSIVE TRAINING/INCENTIVE PROGRAM**

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IDEAL COMPUTER COST ESTIMATING SYSTEM

1. SIMPLICITY
2. INTERACTIVITY - CAD/DESIGN/COST/CONSTRUCTION/
PLAN & SCHEDULE, ETC.
3. HAVE JUDGEMENT FACTOR
4. REVIEW UPDATE CAPABILITY
5. HAVE MAN-HOURS/UNIT LABOR & MATERIAL PRICES
6. PROVIDE DETAIL BREAKDOWN/METRIC CONVERSION

13 +9

IDEAL COMPUTER COST ESTIMATING SYSTEM (CONTINUED)

7. HAVE AUTOMATIC ADJUSTMENT FOR LABOR
MATERIAL
8. HAVE ABILITY TO COMPUTE QUANTITIES
9. CAPABILITY OF DIFFERENT SUMMARY FORMATS
10. DESIGN TO BE TOTALLY INTEGRATED
ARCH/MECH/ELECT/CIVIL
11. DO ALL TYPES OF ESTIMATES - CONCEPTUAL, PER,
DETAIL

14 15 8

OTHER CAPABILITIES - IDEAL FEATURES, WITH EMPHASIS ON CAD/ESTIMATING FOR QUANTITIES, WERE THE BASIS FOR THE AUTHOR ADVOCATING THE CAD/ACE SIMPLE CONCEPT SINCE 1980 AND PROJECTING A STATE-OF-THE-ART PROJECT INTEGRATED COMPUTERIZATION (PIC) CONCEPT TO INTEGRATE DESIGN, SPECIFICATIONS, COST, CONSTRUCTION, PLAN AND SCHEDULE, MANAGEMENT AND OCCUPANCY - INTERACTIVE INTEGRATED SYSTEMS. THIS IS A SIMPLE CONCEPT TO GET THE QUANTITIES FROM COMPUTER AIDED DESIGN SYSTEM AND USE A LINKAGE PROGRAM TO HOOK UP TO A CSEI ORR-TYPE SYSTEM TO MAKE COST ESTIMATES AUTOMATICALLY, SET UP WITH COST CODES FOR BUDGET, PRELIMINARY AND DETAIL ESTIMATING.

- 15 16
- JUNE 1982 IMPACT OF CAD ON COST ENGINEERING
 - DECEMBER 1982 - O'GRADY GODDARD'S CAD SYSTEM
 - 1ST CAD ESTIMATES, 83-86,
SHAFFER-OWENS-CORNING
COMPUTERVISION/ORR/APOLLO/AUTOTROL/FOCUS/ IBM
IN 80% LESS TIME
 - AUGUST 1985 - KSC VAX/CAD CONTRACT \$1,350,059
(\$31,500 ESTIMATING)
 - EARLY 1986 - IBISCALC, ESTIMATING QUANTITIES/
CORRELATION TABLES

- 16 17 18
- O AUGUST 1986 - PERKINS/BROWN TO HUNTSVILLE FOR IBISCALC PYRAMID ASSEMBLY PROGRAM DEMO
 - O JANUARY - APRIL 1987, NAVY/DE DATABASE APPROVAL
 - O JANUARY 1988 - EGG, IBISCALC PRELIM REQUIREMENT
 - O MARCH 1988 - EGG, BRINGS PAT TURNER ON BOARD FOR CAD/ACE
 - O MARCH 1988 - BRINKS/INTERGRAPH/IBISCALC TRAINING DEMO TEAM CREATES APDP/AQUA/IBISCALC CHARTS
-

- 17 18
- O APRIL 1988 DF PRESENTATION FOR DESIGN PROJECTS
 - O JULY 1988 - DRAFT PRINTOUT, INTERGRAPH/IBISCALC/ NAVY DATABASE
 - O OCTOBER 1988 - BRINKS BRIEFING/OVERVIEW - GOALS, PROBLEMS, SOLUTIONS

(10)

GOALS: TO MAKE CAD/ESTIMATES AUTOMATICALLY;
TO SAVE TIME AND MONEY; TO IMPROVE ACCURACY OF
QUANTITY TAKE-OFF, PRICES OUT AND MARK-UP; TO
ALLOW MORE TIME FOR VALUE/COST ENGINEERING,
ETC.; AND TO REDUCE TURN-AROUND TIME ON
CRITICAL PROJECTS FROM WEEKS TO DAYS.

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POSSIBLE SOLUTIONS TO ESTIMATING PROBLEMS

- WHEN DESIGN ON CAD - BILL OF MATERIALS FROM
CAD TO AQUA TO IBISCALC - PULL FROM NAVY COST
DATABASE TO PRICE OUT AND MARK UP TO REDUCE
ESTIMATING TIME 40-70%

21 21 (11)
POSSIBLE SOLUTIONS TO ESTIMATING PROBLEMS

(CONTINUED)

- O ALLOW ESTIMATOR/COST ENGINEER TO:
 - 1. ADD LINE ITEMS MISSING FROM ESTIMATE
 - 2. ADJUST PRICES FOR A PARTICULAR PROJECT BY EXPERIENCE; VENDOR QUOTES, COST ANALYSIS
 - 3. MAKE REPORTS AND SUMMARIES FOR DIFFERENT SITUATIONS - COST ENGINEERING, COST REDUCTION, PLAN AND SCHEDULE, ETC.

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POSSIBLE SOLUTIONS TO ESTIMATING PROBLEMS

(CONTINUED)

- O ALLOW ESTIMATOR/COST ENGINEER TO (CONTINUED) :

- 4. HAVE MINIMUM COST ENGINEERING COMPUTER DATA ENTRY INPUT - TEN LINE ITEMS OF COMMANDS TO GET ESTIMATE

DATA BASES: NAVY, NASA KSC, CACES,
REFERENCE PROJECT

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POSSIBLE SOLUTIONS TO ESTIMATING PROBLEMS

(CONTINUED)

- O WHEN THE DESIGN IS NOT ON CAD - A SONIC DIGITIZER SYSTEM TO SPEED UP ESTIMATING TAKE-OFF AND MAKE COMPUTER AIDED ESTIMATING FASTER AND EASIER, BUT NOT AS FAST OR AS ACCURATE AS CAD/ACCE.

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POSSIBLE SOLUTIONS TO ESTIMATING PROBLEMS

(CONTINUED)

O PROTOTYPES

1. ELECTRICAL DESIGN PROJECT - T3-T4
(COMPLETE FEB/MAR 89)
2. CONCRETE, MASONRY, OFFICE, LAB, 4100 SF
CMU - PSCL (COMPLETE NOV 88 - MAR 89)
3. PRE-ENGINEERED METAL BUILDING (PEMB)
(JUL - OCT 90)

24 25 (13)

OLF T3/T4 BIDS

1.	GOVERNMENT ESTIMATE	\$385,282	
2.	GF&L	\$396,000	+2.8%
3.	EAST BAY ELECT.	\$397,227	+3.1%
4.	MILITARY CONST., INC.	\$398,770	+3.5%
13.	HIGH BIDDER	\$513,220	

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THE 39 STEPS FOR DEVELOPING CAD ESTIMATES

APDP

1. CREATE (OR COPY) PROJECT (SEE FIGURE 15)
2. CREATE (OR COPY) DDL (DATA DEFINITION LANGUAGE)
3. ADD "AQUA" ATTRIBUTES
4. ADD CODE LIST #4 - FINISHES
5. CREATE (OR COPY) CLASS CODE TABLE
6. "PLAN" WHICH DRAWINGS ARE ON WHICH FLOORS

THE 39 STEPS FOR DEVELOPING CAD ESTIMATES (CONTINUED)

APDP (CONTINUED)

7. CREATE (OR COPY) DRAWINGS
8. PLACE/MANIPULATE GRAPHICS
9. "TRACE" ROOM PERIMETERS
10. COMPILE DATABASE - CAN BE DONE ANY TIME
AFTER STEP 4
11. LOAD DESIGN FILE
12. INSERT FLOOR TO DRAWING RELATIONS (SEE FIG.
9, CLASS CODE GUIDE)

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THE 39 STEPS FOR CAD ESTIMATING

- O STEP 12A - TWO-WAY CONVERSION* OR TRANSFER - ^{-TO-} APDP PROJECT ARCHITECT
 - TAKES PROJECT ARCHITECT FILE TO 3D; CONVERTS IT TO APDP 2D FILE
OR VICE VERSA
 - TAKES APDP 2D FILE AND CONVERTS IT TO PROJECT ARCHITECT 2D
- O THEN YOU REDO STEPS 3, 10, 11 & 12; AFTER CONVERSION PROJECT ARCH TO APDP
- O PURPOSE
 - FOR CAD ESTIMATING TO ALLOW YOU TO MAKE CAD ESTIMATES WITH PROJECT ARCHITECT USING THE IBIS-CALC ESTIMATING PROGRAM, WITH NAVY DATA BASE, AND TO INTERFACE WITH GENERIC ESTIMATING PROGRAMS
 - ALSO, TO MAKE IT POSSIBLE TO BRING IN MECHANICAL, ELECTRICAL, CIVIL, ETC., TO APDP AND IBIS-CALC

*NOTE: AVAILABLE APRIL 1991, PER DISCUSSION WITH DAVE MUELER AND JAN PALIN
ON 1/25/91

THE 39 STEPS FOR DEVELOPING CAD ESTIMATES (CONTINUED)

AQUA

13. MANIPULATE FINISHES USING THE TUTORIAL
14. ESTABLISH RELATIONS
15. LABEL ELEMENTS AND GRAPHIC GROUPS
16. RUN AQUA REPORT OPTION
17. REVIEW QUANTITIES AND CROSS CHECK

AQUA REFERENCE GUIDE FOR CLASS CODES/CORRELATION TABLE

TYPE	ELEMENT	Q-A	Q-B	Q-C	Q-D	Q-E
A	WALL	GROSS AREA	LENGTH	WIDTH	HEIGHT	---
M	CURTAIN WALL	GROSS AREA	LENGTH	WIDTH	HEIGHT	---
B	COLUMN	VOLUME	LENGTH	WIDTH	HEIGHT	PERIMETER
C	BEAM	VOLUME	LENGTH	WIDTH	HEIGHT	PERIMETER
D	SLAB	GROSS AREA	THICKN	PERIM	---	---
K	SLAB OPENING	--- AREA	THICKN	PERIM	---	---
E/F	DOOR F WINDOW	1	AREA	WIDTH	HEIGHT	SILL HGT
L	COMPONENT	1	LENGTH	WIDTH	AREA	---
G	FLOOR FINISHING	AREA	PERIM	HEIGHT	---	---
H	CEILING FINISH	AREA	PERIM	HEIGHT	---	---
J	WALL FINISHING	GROSS AREA	LENGTH	WIDTH	---	---
N	WALL FIN OPENING	--- AREA	LENGTH	HEIGHT	SILL HGT	TOTAL HGT

THE 39 STEPS FOR DEVELOPING CAD ESTIMATES
(CONTINUED)

IBIS

18. GENERATE CORRELATION TABLE (SEE FIG. 10,
SAMPLE CORRELATION TABLE)
19. EDIT CORRELATION TABLE
20. CREATE IBISCALC INPUT FILE
21. EDIT IBISCALC INPUT FILE
22. CREATE THE NEW PROJECT

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THE 39 STEPS FOR DEVELOPING CAD ESTIMATES
(CONTINUED)

IBIS (CONTINUED)

23. PROCESS INPUT FILE INTO PROJECT
24. ACTIVATE REFERENCE PROJECT (NAVY DATABASE
OR KSC UNIQUE HISTORICAL DATABASE)
25. FROM TOP LEVEL OF PROJECT, SAVE TRIANGLE TO
GET PRICES AND SUBSTRUCTURES
26. CALCULATE AND PRINT ESTIMATE BY SPEC CODE
27. ADD CIVIL, MECHANICAL, ELECTRICAL CODES AND
QUANTITIES

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THE 39 STEPS FOR DEVELOPING CAD ESTIMATES
(CONTINUED)

COST ENGINEERING (CONTINUED)

28. ADD NEW PRICES FOR MISSING PRICED ITEMS,
ADJUST PRICES FOR EACH UNIQUE PROJECT
(QUANTITIES AND HEIGHT)
29. REVIEW COST ESTIMATES FOR ACCURATE QUANTI-
TIES AND PRICES
30. ADD MISSING COST LINE ITEMS NOT ON DRAWING,
IN SPECS, ETC., SUCH AS TESTING, SCAFFOLD-
ING, CONSTRUCTION, CRANES, HOISTS, TRUSSES,
ETC.
31. DO COST ANALYSIS OF ALL MAJOR COST ITEMS,
VENDOR QUOTES, ETC.

THE 39 STEPS FOR DEVELOPING CAD ESTIMATES
(CONTINUED)

COST ENGINEERING (CONTINUED)

32. SUMMARIZE MARK-UP; DO OTHER SUMMARIES, ETC.
33. REVIEW OVERALL ESTIMATE
34. APPLY BID/MARKET STRATEGY - SPECIAL
CONDITIONS, JOINT OCCUPANCY, DOWN TIME
COSTS, ETC.
35. FINAL MARK-UP (PERCENTAGES)
36. ADJUST FOR LATE VENDOR QUOTES, AMENDMENTS

THE 39 STEPS FOR DEVELOPING CAD ESTIMATES (CONTINUED)

COST ENGINEERING (CONTINUED)

37. FINAL CHECK
38. APPROVE BID ESTIMATE AND GET SIGNATURES
39. GET BID IN ON TIME

CAD/ACCE PROBLEMS, DIFFICULTIES AND CHALLENGES

1. APDP DRAWING NOT COMPLETE FOR PSCL:
GRAPHICS, CONCRETE AND BLOCK; DIMENSIONS;
DESCRIPTIONS, FINISHED SCHEDULE
2. IBISCALC FORMAT - SUMMARY OF LABOR AND
MATERIAL, UNIT QUANTITIES AND UNIT PRICES;
SEPARATE LABOR AND MATERIAL MARK-UPS (IBIS-
CALC VERSION 3.0 TO SOLVE THESE PROBLEMS)
3. PRESENT INTERGRAPH CAD, IBISCALC, NAVY
SYSTEM, RELATIONSHIP NOT COMPLETE - CIVIL,
MECHANICAL AND ELECTRICAL NOT INTEGRATED
(SOME MECHANICAL AND ELECTRICAL CAN BE
INCORPORATED AS COMPONENTS IN APDP)

CHALLENGES (CONTINUED)

4. MANY QUANTITIES MISSING FROM APDP/AQUA - FOUNDATIONS, STRUCTURAL, ETC.
5. THE EXCESSIVE TRAINING TIME REQUIRED TO UNDERSTAND AND USE THE SYSTEM (10 - 24 WEEKS). IT IS HOPED THAT WITH THE WORK STATION CONCEPT AND EVOLUTION OF CAD ESTIMATING, THIS MAY BE CUT TO 1 - 2 WEEKS.

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CAD/ACCE PROBLEMS, DIFFICULTIES AND CHALLENGES

(CONTINUED)

6. KEEPING COMPUTERIZED COST DATA UP TO DATE FOR LOCAL AREAS
7. LIMITED BUDGET, PRIORITY, RESOURCES, TO IDEALLY CUSTOMIZE CAD/ACCE SYSTEM MICRO-STATION FOR AUTO CAD COMPETITION
8. DIFFICULTY MAKING CAD/ACCE FASTER, SIMPLE AND EASY TO USE
9. DIFFICULTY IN GETTING A&E'S TO USE INTELLIGENT CAD, APDP (AUTO CAD - CHEAPER AND EASIER TO LEARN AND USE)

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**CAD/ACCE PROBLEMS, DIFFICULTIES AND CHALLENGES
(CONTINUED)**

10. LOW PRIORITY ALLOCATED TO PROCESSING
CAUSES THE SLOW VAX COMPUTER SOFTWARE/COST DATABASE LOADING TIME OF 27 HOURS
11. LACK OF USER (COST ENGINEERING) INPUT IN SOFTWARE PROGRAM DEVELOPMENT (INTERGRAPH MAY BE HIRING A COST ENGINEERING CONSULTANT)
12. DIFFICULTY IN PUTTING TOGETHER OFF-THE-SHELF PROGRAMS (APDP, AQUA, IBISCALC) FOR CUSTOMIZED GOVERNMENT APPLICATION

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CHALLENGES

13. THE NEED FOR INDUSTRY STANDARDIZATION, ARCHITECTURAL, STRUCTURAL, MECHANICAL AND ELECTRICAL CAD INPUT DATA, SO PRICING CAN BE MORE ACCURATE
14. THE NEED FOR COST ENGINEERING STANDARDS OF COST CODES (SPEC DESCRIPTION - WE USED NAVY COST CODES DATABASE (GOOD HOPE FOR MOU, OCTOBER 1988, TRI-SERVICE AUTOMATED COST ENGINEERING SYSTEM)
15. THE BILL OF MATERIALS QUANTITIES FROM CAD PROGRAMS ARE NOT NECESSARILY THE CONSTRUCTION ESTIMATING QUANTITIES NEEDED TO MAKE A DETAILED CONSTRUCTION COST ESTIMATE. THE AQUA/IBISCALC ESTIMATING PROGRAM HELPED SOLVE THIS PROBLEM WITH A CORRELATION TABLE WHICH ALSO ALLOWED ADDING ADDITIONAL ESTIMATE QUANTITIES.

CHALLENGES (CONTINUED)

16. THE CAD DRAWINGS MUST BE COMPLETE (WITH INTELLIGENT INFORMATION) TO OBTAIN ACCURATE QUANTITIES. A SPECIAL ESTIMATION/COST ENGINEERING REVIEW STEP WILL BE REQUIRED.

17. GOVERNMENT ESTIMATING REQUIRES A DETAIL DESCRIPTION, QUANTITY, UNIT LABOR, TOTAL LABOR, UNIT MATERIAL, TOTAL MATERIAL AND TOTAL LINE ITEM COST COLUMN FOR EACH LINE ITEM (FOR MARKUPS FOR LABOR, TAXES, INSURANCE, AND MATERIAL, EQUIPMENT TAXES).

CHALLENGES (CONTINUED)

18. IT IS MOST IMPORTANT THAT THESE ESTIMATING PROGRAMS CAN UPDATE THE COST DATABASE EASILY FOR LOCAL AREAS, ETC. THIS IS ANOTHER ENHANCEMENT NEEDED. WE PLAN TO WORK THIS WITH THE NAVY (CES).

19. THE DIFFICULTIES IN GETTING A&E'S AND DESIGN ENGINEERS TO USE THE CAD, WITH INTELLIGENT DRAWING CONCEPT, SINCE IT IS STILL MORE EXPENSIVE INITIALLY. HOWEVER, WITH WORKSTATION CAD AND INDUSTRY STANDARDIZATION, MORE COST EFFECTIVE HARDWARE AND SOFTWARE, SIMPLER SYSTEMS, AND EDUCATION; THIS PROBLEM WILL GRADUALLY BE SOLVED, AS THE BENEFITS OUTWEIGH INITIAL COST, EXTRA LEARNING, ETC.

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CHALLENGES (CONTINUED)

20. THE HARDWARE/SOFTWARE PROGRAM DEVELOPER FAILURE TO HAVE ADEQUATE END USER (COST ENGINEER) INPUT, REQUIREMENTS AND RESPONSIBILITIES IN TOTAL SYSTEM DEVELOPMENT IS A COMMON PROBLEM IN COMPUTER PROGRAM DEVELOPMENT. BY EMPHASIZING THIS PROBLEM HERE AND NOW, IT IS HOPED THAT THE NEXT GENERATION WILL BE WISER, RESULTING IN A FASTER, CHEAPER, EASIER TO USE AND MORE COST EFFECTIVE PRODUCT.

21. THE EXCESSIVE AMOUNT OF CUSTOMIZATION FOR EACH USER IS AN EXPENSIVE HIDDEN COST CONSIDERATION. WITH INDUSTRY STANDARDIZATION, WORKSTATION CAD, LINKED TO GENERIC COMPUTER COST ESTIMATING SYSTEMS SUCH AS CES, MC2, BAUTEC/ACCESS, TIMBERLINE, THIS PROBLEM SHOULD BE REDUCED TO AN ACCEPTABLE LEVEL; KEEPING IN MIND THAT EACH USER WILL HAVE UNIQUE REQUIREMENTS, MOST OF WHICH SHOULD BE SOLVED WITH A MORE FLEXIBLE CAD/ACE.

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CHALLENGES (CONTINUED)

22. THE PROBLEM OF KEEPING CAD/ACE SIMPLE IS PROBABLY ONE OF THE MOST DIFFICULT AND YET THE MOST NECESSARY FOR ACCEPTANCE BY A&E'S, OWNERS, GOVERNMENT MANAGEMENT, AND PRIMARILY, THE ESTIMATORS/COST ENGINEERS. IT IS HOPED THE SIMPLISTIC WORKSTATION CONCEPT AS COMPARED TO THE MINI-COMPUTER SYSTEM WILL BE A MAJOR STEP TO SIMPLIFY CAD/ACE. WE WILL CONTINUE WORKING ON THIS WITH FUTURE ENHANCEMENTS.

22A. CAD/ACE NEEDS TO REDUCE THE 39 STEPS TO TEN STEPS. THIS SHOULD BE ACCOMPLISHED AFTER THE 15 TO 20 PROJECTS ARE ESTIMATED AND MANY OF THE USER VARIABLES CAN BE IDENTIFIED, EVALUATED AND AUTOMATED.

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CHALLENGES (CONTINUED)

23. MAKING THE CAD/ACE EASIER TO USE HAS BEEN ONE OF THE BIGGEST CHALLENGES, SINCE ESTIMATING/COST ENGINEERS REQUIRE YEARS OF EDUCATION AND EXPERIENCE, AND ESTIMATING MAY VARY WITH EACH PROJECT, EACH ESTIMATOR AND COST ENGINEER. OUR WORK HAS BEEN MAINLY CENTERED ON DETAIL LABOR AND MATERIAL GOVERNMENT ESTIMATES AS REQUIRED BY TM 5-800, KSC SPEC G-0002, AND THE NAVY CES. DUE TO LIMITED R&D FUNDING, WE HAVE BEEN IN TRYING TO CUSTOMIZE AND INTEGRATE MANY DIFFERENT HARDWARE AND SOFTWARE PROGRAMS WHICH REQUIRE MANY SEPARATE AND DISTINCT OPERATIONS. THIS CAN BE NOTED BY THE 39 STEPS SHOWN PREVIOUSLY TO MAKE CAD/ACE, LINKING 39 SEPARATE/DIFFERENT

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PROGRAMS TO MAKE AN ESTIMATE. THE NEW WORKSTATION CAD/ACE SHOULD BE EASIER TO USE SINCE IT IS BEING DESIGNED AND INTEGRATED FOR THE WORKSTATION WITH ELEVEN SOFTWARE PACKAGES IN MIND AND BEING DESIGNED FOR SOME OF THE MORE POPULAR THIRD PARTY COMPUTER ESTIMATING PROGRAMS SO THE ESTIMATOR CAN USE THE PROGRAM HE IS MOST FAMILIAR WITH AND EXPERIENCED IN, THAT ALSO FITS HIS NEEDS BEST. AN EXAMPLE IS KSC AND NAVY USING CES WHICH IS BEST SUITED FOR GOVERNMENT WORK. THE Q-CAPTURE WITH UNINTELLIGENT DRAWINGS ALSO COULD MAKE IT EASIER TO ADD THE UNIQUE ITEMS NOT IN CAD/ACE. IT WILL BE USED BY A&E/ESTIMATORS/COST ENGINEERS WITHOUT ACCESS TO CAD/ACE TO START USING COMPUTER ESTIMATING TOOLS. THIS WAY, THEY WILL BE READY WHEN THEIR FIRMS START USING INTELLIGENT CAD AND CAD/ACE.

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CHALLENGES (CONTINUED)

24. DO AS MUCH AS POSSIBLE AUTOMATICALLY, TRY TO LIMIT THE CAD/ACE TO LITTLE DATA ENTRY SINCE, MOST ESTIMATORS APPARENTLY DISLIKE THIS REQUIREMENT OF PRESENT COMPUTER ESTIMATING SYSTEMS. IT IS HOPED THAT MANY STEPS CAN BE AUTOMATED THROUGH ADVANCED PROGRAMMING, ARTIFICIAL INTELLIGENCE, VOICE RECOGNITION, ETC. THE BASIC CONCEPT IS TO USE CAD FOR QUANTITIES AND TO USE QUANTITY EXTRACTION SOFTWARE AND CORRELATION TABLES FOR COST CODES, SPECIFICATIONS AND DESCRIPTIONS; AND OTHER TOOLS, SUCH AS DATABASE MANAGEMENT SYSTEMS, FOR LISTING AND PRICING OUT - A SPREAD SHEET TYPE PROGRAM FOR PRICING OUT AND MARKING UP THE COST ESTIMATE - AND A REPORT

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WRITING PROGRAM FOR FORMATTING OF REPORTS AND FOR GIVING IT THE AUTOMATIC FLEXIBILITY NOT THOUGHT POSSIBLE NINE YEARS AGO WHEN THE CAD/ACE CONCEPT WAS FIRST ADVOCATED.

48 49 (25)
ACCOMPLISHMENTS - THE ESTIMATES WERE DELIV-
ERED ON 11/17/88 AND 3/89 AND PROVED THAT:

1. A PROJECT CAN BE ESTIMATED FROM CAD QUANTITIES TO GET A FAIR AND REASONABLE COST ESTIMATE.
2. THE ARCHITECTURAL ASSEMBLIES, ELEMENTS, WALL, FLOOR, CEILING AND COMPONENTS CAN BE USED INSTEAD OF A DETAIL DATABASE MANAGEMENT SYSTEM REQUIRING COST/ITEM FOR EACH AND EVERY ITEM IN A BUILDING, THUS SAVING 10-50% OF DATA LINE ITEMS IN CAD DRAWINGS QUANTITIES.

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ACCOMPLISHMENTS (CONTINUED)

3. THIS EFFORT IS FORCING THE DEVELOPMENT OF THE NEXT GENERATION WORKSTATION CONCEPT WITH INTEGRATED CIVIL, STRUCT, ARCHITECT, MECH AND ELECT DESIGN PACKAGES TO GET A TOTALLY INTEGRATED COST ESTIMATING SYSTEM MORE AUTOMATICALLY.
4. THIS EFFORT HAS ACCELERATED CAD ESTIMATING DEVELOPMENT (FOR MINI-COMPUTERS, WORK STATIONS, AND MAIN FRAMES).

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WORKSTATION PRODUCTS

<u>PRODUCT</u>	<u>DESCRIPTION</u>	<u>APPLICATION</u> <u>AVAILABLE</u>	<u>QUANTITY EXTRACTION</u> <u>AVAILABLE</u>
P ARCE	FLOOR PLANS - 2D DATABASE	NOW	NONE
	FLOOR PLANS - 3D DATABASE	4Q 89	1Q 90
	REFLECTED CEILING - 2D DATABASE	NOW	NONE
	REFLECTED CEILING - 3D DATABASE	4Q 89	1Q 90
	SECTIONS/ELEVATIONS - 3D DATABASE	4Q 89	1Q 90
IN-ROADS	CIVIL SITE - 3D DATABASE	NOW	1Q 90
P-LAYOUT	SPACE PLANNING - 2D DATABASE	NOW	NONE
	SPACE PLANNING - 3D DATABASE	4Q 89	1Q 90
MODEL DRAFT	STRUCTURAL MODELING - 3D DATABASE	NOW	1Q 90
PE HVAC	HVAC - 3D DATABASE	4Q 89	2Q 90
PE ELEC	ELECTRICAL WIRING - 3D DATABASE	4Q 89	2Q 90
PE PLUMB	PLUMBING/PIPING - 3D DATABASE	1Q 90	2Q 90
Q CAPTURE	QUANTITY CAPTURE FROM DUMB DRAWING	2Q 90	2Q 90

5. A MULTI-PLATFORM/SOFTWARE CAD ESTIMATING SYSTEM HAS NOW BEEN INTEGRATED ON ONE COMPUTER ESTIMATING SYSTEM.

6. THIS EFFORT SHOWS THAT USEFUL ESTIMATING QUANTITIES CAN BE OBTAINED FROM INTELLIGENT CAD SYSTEMS.

SUMMARY - WE ARE CONTINUING TO DEVELOP A MINI-COMPUTER/CAD/ESTIMATING WITH THE STAND-ALONE VERSION AND REQUESTING MORE CAD/APDP DESIGN PROJECTS, WHILE ADVOCATING AND COOPERATING IN THE DEVELOPMENT OF THE OTHER VERSIONS OF CAD/ACE. WE HOPE THIS WILL BE THE FUTURISTIC COST ESTIMATING SYSTEM THAT WILL PROVIDE TIME FOR MORE COST ENGINEERING, MORE COST EFFECTIVE AND EFFICIENT CONSTRUCTION FOR GOVERNMENT AND AEROSPACE, AND ULTIMATELY FOR YOU, THE CONSUMER AND TAXPAYER. SUCH A COST ESTIMATING PACKAGE WOULD ASSIST IN THE CONTINUATION OF OUR AMBITIOUS SPACE PROGRAM, AND ASSIST THE UNITED STATES IN CONTINUED PREEMINENCE IN SPACE EXPLORATION DEVELOPMENT, ATTAINING OUR NEW GOALS FOR SPACE STATION, TO THE MOON AND TO MARS.

